

REMARKS

A petition for a one month extension of time has today been filed as a separate paper and a copy is attached hereto.

Newly presented claim 31 is similar to cancelled claim 26 but narrowed to limit the nitrogen-containing gas, to which the hydrocarbon is added, to N_2O . New independent claim 29 is broader than claim 26 in that the step of cleaning with an ammonia plasma to remove surface oxide is omitted.

By the present amendments, all claims are now limited to those preferred embodiments employing a hydrocarbon in the process gas from which the plasma is formed and applied to the surface of the copper wiring layer to convert a surface portion of that layer to a copper diffusion preventing layer. As explained at page 12, lines 2-6 of applicants' original specification these embodiments offer the advantage that "a thin film of hydrocarbon is formed on the copper wiring layer, and the copper wiring can be difficult to be etched in later steps by the thin film of hydrocarbon."

In the last office action claims 26 and 3 were rejected over Ngo et al in view of Smith et al. It is respectfully submitted that this rejection is not viable with respect to the new claims as presented here which define the process gas, which is converted to a plasma for forming the copper diffusion layer, as "containing N_2O and a hydrocarbon." Ngo et al uses "a plasma

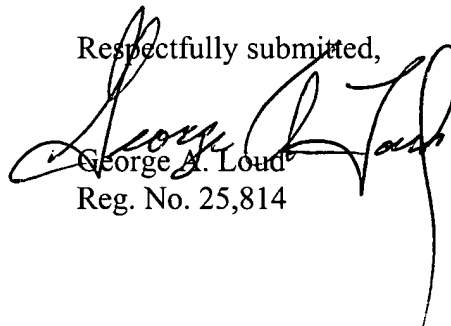
containing ammonia and nitrogen for a brief period of time to reduce the surface oxide...”, quoting from the abstract. The purpose of Ngo in using an ammonia plasma, i.e., reducing the oxide on the surface of the copper layer, would not be served by substituting an oxidizing gas, i.e., N_2O , for the reducing gas. Smith et al teach “a method of passivating an oxygen-sensitive material (such as copper) from oxidation by subjecting the material to a hydrogen-containing (or deuterium-containing) plasma before subjecting the device to an oxygen ambient for any appreciable time,” quoting from column 1, lines 57-62. As the examiner correctly notes, at column 3, lines 51-55 Smith et al teach that nitrogen or argon may be added as a “forming gas” to a hydrogen plasma or a plasma formed from a hydrogen-containing gas. Methane is specifically mentioned as a possible hydrogen-containing gas for use in that “passivation step.” In view of the fact that Smith et al specifically teach that the passivation step should be conducted “before subjecting the device to an oxygen ambient...” it would not have been obvious to add an oxidizing gas such as N_2O to the gas used for passivation against oxidation in accordance with the teachings of Smith et al. It is respectfully submitted that it would not have been obvious to combine the teaching of a passivation step in Smith et al with the teaching of the reducing step in Ngo et al. The two effects are not compatible. The objective of Ngo et al is not to passivate but, rather, to reduce. Further, as noted above, even it were obvious to combine the reducing step of Ngo with the passivation step of Smith et al, it would have been contrary to the purposes of both these references to substitute N_2O for the ammonia or nitrogen.

In rejecting claim 28 in paragraph 9 of the most recent office action the examiner combines the teachings of Lai et al and Smith et al. The only utility taught by Lai et al for use

of an N₂O plasma is for the purpose of increasing the bonding strength between SiN and FSG (fluorinated silicon glass). There is nothing in the teachings of Smith et al which would have motivated one skilled in the art to add a hydrocarbon to that plasma treatment. Smith et al teaches nothing relevant to improving a bond between FSG and any other material. At column 7, lines 64-67 Lai et al suggest that the plasma treatment in question achieves its result by removal of Si-OH bonds. There is nothing in the teachings of Smith et al regarding passivation of copper which would have led one skilled in the art to believe that any useful purpose would be served by adding the hydrocarbon to the plasma treatment of Lai et al. Indeed, as noted above, the use of hydrocarbon and N₂O in combination is incompatible with the objective of Smith et al, i.e., passivation of a copper surface to protect it against an oxidizing atmosphere.

In conclusion, it is respectfully requested that the examiner reconsider the rejections of record in light of the redrafted claims presented here.

Respectfully submitted,



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